

ON THE CONTAINING-TEXTURE OF THE BLOOD.

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FROM THE LONDON MEDICAL GAZETTE.

THE relations which have been established between the process of repair and inflammation, and between these and natural growth, have invested embryological researches with a new interest, especially with reference to the development, properties, and transformations of vascular tissue, or, as it may be more suggestively expressed, *the containing-texture of the blood*. In the primitive trace of growth in the embryo, sentient and motor forms (spinal cord, cerebral ganglia, and heart) are the first moulded, and visible, through a lens, in the incubated egg of the common fowl within the space of forty hours. At this early period there is neither a blood-circulation nor blood vessels. Blood is first seen, not in the embryo-body itself, but in the vascular area, where it primarily appears in irregular, and apparently unconnected red points or blotches, which, when examined with a microscope, are observed to be groups of red cells situated amongst the other cells of this embryonic appendage, and no special limiting or boundary tissue can be distinguished. A growth advances, the amount of blood increases, circulation begins, and the coats of the vessels then become recognisable as a distinct form of tissue interposed between the blood-current and the fixed and more solid portions of the structure. This constitutes the coats of the arteries, veins, and capillaries, as distinguished from the particular substances of the various organs through which blood is distributed, and is, at first, in accordance with the

universal law of growth, a corpuscular, and subsequently a fibrous tissue, increasing gradually in thickness and strength, in the arteries and veins, in proportion to the increase and volume of the blood conveyed; but in the capillaries remaining, as at first, exceedingly thin and transparent.

These facts are, we believe, not disputed, and they are here briefly narrated in order to state the case:—That, in original growth, forms of sentient and motor tissue precede the circulation of the blood; that the circulation of blood precedes the formation of the special coats of the blood-vessels; and that these are at first a corpuscular, and then a fibrous texture.

Experiment 1.—Having opened the shell of an egg after forty or forty-four hours' incubation,—some eggs being earlier than others,—divide the yolk membrane with a pair of scissors all round, just outside the vascular area; then sink the egg slowly in a vessel of water, and the separated portion, which includes the *vascular area*, *area pellucida*, and the *embryo*, will float at the surface, and may be removed upon a slip of glass for microscopical inspection, either as an opaque, or as a transparent object. Blood is seen in the vascular area, in apparently unconnected, irregular, pale red spots, which are larger and more numerous towards the outer circumference than towards the inner margin, where the *area vasculosa* bounds the *area pellucida*. The *area pellucida* is formed by a thick gelatinous sort of membrane, in the centre

of which lies the embryo, with the cerebral ganglion, the two lateral visual ganglia, and the spinal cord, symmetrically moulded. The heart appears as a round transparent vesicle, outside and towards the middle of the body, and has been seen beating regularly, notwithstanding the manipulation to which the embryo and its appendages have been subjected by the removal. No appearance of blood can be detected in any part of the embryo-body: certainly there are no blood-vessels, properly so-called; nor at this time can any capillaries be seen traversing the area pellucida. The whole mass is so extremely soft and tender, that it will not bear the slightest degree of traction.

Experiment 2.—The same proceedings being adopted with an egg of from

forty-eight to fifty-two hours' incubation, the trunks of two large blood-vessels are seen emerging, one on each side, from beneath the body of the embryo, some distance below the heart, and one from the heart passes upwards by the head. They traverse the area pellucida, and, reaching the inner margin of the area vasculosa, divide and sub-divide: then, the smaller sub-divisions returning to the inner margin of the area vasculosa, numerous capillaries are seen passing across the area pellucida towards the body of the embryo (figs. 1 and 2). Blood-corpuscles are now seen circling within the heart upon each pulsation; and others are at the same time also seen moving within those portions of the trunks of the vessels which traverse the area pellucida.

FIG. 1.

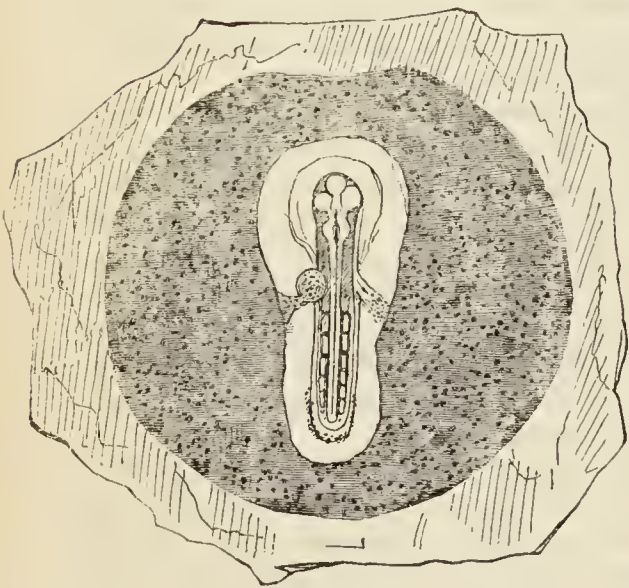


FIG. 1.—The embryo, area pellucida, and vascular area of the egg of the common fowl, after forty hours' incubation. Magnified by a lens.

With respect to these vessels, a special blood-containing texture can scarcely yet be said to have formed, inasmuch as the blood-currents traversing the area pellucida are bounded only by the material of that membrane, which is quite transparent; and those ramifying in the area vasculosa are bounded by the

FIG. 2.



FIG. 2.—The embryo, capillaries of the area pellucida, and vessels of the vascular area, after fifty hours' incubation. Magnified by a lens.

material of that substance—the altered yolk-cells, and are therefore much more opaque. Moreover, the whole mass is still so soft and pulpy, that it will not bear the most gentle traction without obliteration, falling into a confused mass of cells; though it becomes more coherent after exposure to the air. This

is not the character of vascular tissue. The correct anatomical description appears to be this (not only as respects the appendages of the embryo, but also as respects the embryo-body itself):—Whatever substance or texture blood first circulates in, the blood-channels are, for a brief space of time, formed or bounded by that substance; so that, at first, no distinction can be observed between the coats of the blood-vessels and the substance lying in the intervals or spaces between them: whereas afterwards, when the body is more fully grown, and the volume of blood increased, a very important distinction arises between the containing-tissue of the blood, or the coats of the blood-vessels, and the *parenchyma*, or the particular substance of an organ. We cannot select a better illustration than the blood-vessels of the area vasculosa. The yolk of the egg consists of a very thin transparent membrane containing the yolk-cells. The germinal membrane is an altered state of the yolk membrane, and the vessels of the area vasculosa appear projecting into the yolk substance; so that, on their upper or *parietal* aspect, they are smooth and transparent, but, on their lower or *visceral* aspect, they are yellow and opaque. Three parts of their circumference—that is, of their walls—are formed of cohering yolk-cells; the other part by the transparent and smooth yolk membrane.

In the increase and preservation of the human body we recognise three normal phenomena—growth, nutrition, and the process of repair; in its diseases, two prominent abnormal conditions—inflammation and scrofula. Respecting these we distinguish three things:—1, the blood; 2, the coats of the blood-vessels, or the containing texture of the blood; and 3, the particular substances of the different organs.

Of the blood we have on several previous occasions treated at length, especially with reference to its colourless elements—lymph and lymph-particles, or, as we have elsewhere more frequently termed them, protoplasma and colourless cells.* We now purpose to speak particularly of the containing-tissue of the blood—or, as we may more briefly term it, vascular tissue—with respect

to the distinctive properties, reproduction, and transformations it exhibits in phenomena of repair, inflammation, and scrofulous disease.

The containing-texture of the blood—The coats of the blood-vessels, or vascular tissue, may be described as a sort of frame-work, in the interstices of which are deposited the various substances by which individual organs are characterised. It is these which impart the sensible qualities by which the organ is distinguished, and it is their constant and intimate admixture with the vascular tissue which prevents the special properties of the latter from being readily appreciable. In repair, inflammation, and scrofulous disease, we meet with new growth and new blood-vessels, the primary elements of which, all observers concur in stating to be forms of lymph and lymph-particles, capable of assuming, by a species of metamorphosis, a fibrous, tendinous, or osseous structure. A bone is composed not simply of bone-substance, but also of vascular tissue. Blood-vessels spread everywhere upon the bone-substance, which is full of hollow spaces and passages for their distribution. At the early periods of growth blood and vascular tissue predominate, and a bone is therefore, at that time, soft and yielding; but afterwards the bone-substance preponderates,—yet so that a bone is never without an expanse of vascular tissue permeating its cavities. When a fracture occurs, the process of repair consists in the reproduction of bone-substance; and the agents and materials employed are blood and the vascular tissue of the injured bone.

The phenomena, for our present purpose, may be shortly stated as follows:—Lymph is effused, forming a lymph-bed, which surrounds and envelopes the injured and irritated vessels; new blood-vessels form in the lymph, which is thereby converted into a species of lymph-fabric. This constitutes the primary form of the new vascular tissue,—a kind of granulation-structure, endowed with properties of growth and metamorphosis, and which, first changing into fibrous tissue, is finally converted into bone; the order of the transformations being here, and in all cases, lymph, vascular lymph or granulation-texture, fibrous texture, and bone.*

* MEDICAL GAZETTE, vols. i. and ii., 1840-41; Transactions of the Provincial Medical and Surgical Association, vols. xi. and xii.; and Provincial Journal.

* On Healthy and Diseased Structure, &c. 1849; also the Lectures on Repair by Mr. Paget.

Tendons consist of strong fibrous threads or cords, enveloped, and, as it were, bound together by vascular tissue. When a tendon has been ruptured, the process of repair appears, in all its primary stages, to be similar to that observed in bone. Effusion of lymph precedes the formation of new vascular tissue: analogously as in the embryo, the cells of the germinal membrane precede the vascular area. But here the transformations are limited to the fibrous type, not proceeding to the ulterior form of bone: and we readily perceive in this example, that whether the primary lymph-form persist, or whether the transformations exceed the natural fibrous form,—in either case the reparation *of the tendon* would be unnatural, and an abnormal or diseased condition would exist. The skin has a much more complex organisation than either a bone or tendon. It may be described as a web or frame-work of vascular tissue, in which are embedded, at variable depths from the surface, the particular substances of its very numerous perspiratory glandulæ and hair-follicles. The phenomena of repair in the skin vary according to the nature and severity of the injury inflicted, or according as the before-mentioned organs embedded in it are more or less extensively and completely destroyed. The general results of scalds and burns, which exemplify phenomena of inflammation and repair, are well known. In the former, blood speedily accumulates, reddening the site of the injury, and phenomena of growth or nutrition are exaggerated. The cuticle is raised into a bladder filled with fibrinous serum, and lymph and lymph-particles form a new covering to the excited and distended vessels. These are succeeded by several layers of new cuticle, beneath which the vessels gradually resume their natural calibre and appearance, and the reparation is complete. In burns the injury is deeper, vascular tissue and its embedded organs being killed or destroyed. Hence a new growth of vascular tissue is required for reparation, the phenomena of which may be briefly summed up as follows:—At a certain depth from the surface vascular tissue regains its tone and properties, whereupon blood flows in increased quantity to the irritated vessels, lymph is effused, and thus a line of demarcation is drawn between the living

and the dead textures. New blood-vessels form in the lymph, which thereby becomes new vascular tissue, endowed with properties of secretion and metamorphosis; and when, by the removal of the dead parts, this new vascular tissue comes into view, it is in the form of extremely red points, termed *granulations*, which bleed upon the slightest touch,—a fact indicative of the corpuscular or embryoniform condition of the coats of the new vessels. The granulations metamorphose into fibrous texture termed cicatrix, upon which *the cure*, in as far as natural operations are concerned, is completed. All these cases may be considered as examples typical of inflammation, repair, and cure: and it is to be observed that bone does not exude from bone, tendon from tendon, nor skin from skin; but that in each case a corpuscular growth, termed effusion of lymph, first appears. This, when permeated by blood-currents, becomes new vascular tissue, the metamorphosis of which effects the cure, whether that cure demand an osseous or a fibrous texture. Moreover, it is also to be observed,—at first, during the formation of new vascular tissue or granulations, that *the action is from the blood to the tissues*,—there is deposition, or effusion, growth, secretion, and swelling: but subsequently, during the fibrous and osseous transformations, *the action is from the tissues to the blood*; these latter periods being marked by diminution of swelling, absorption, consolidation, a less amount of blood circulating in the part, and disappearance of a great many of the new vessels.

Respecting the relations subsisting between the lymph of repair and the lymph of the blood,—that is to say, between the colourless granular cells and protoplasma of new vascular tissue, and the colourless granular cells and protoplasma of the blood,—the following facts, which have elsewhere been discussed, may here be recapitulated:—Colourless cells are found in abundance in blood taken from vessels administering to repair or inflammation, and a delicate web of fibrous tissue may be seen with a microscope to form in the protoplasma or liquor sanguinis. The blood of the early embryo, when vascular tissue is in active growth, is scarcely more than lymph: the vessels of granulations are formed of lymph, and bleed upon the mere touch; and

lymph and lymph particles adhere to the coats of the vessels upon irritating them. Moreover, when blood is withdrawn by venesection from a person labouring under an inflammatory disease, lymph separates quickly in a thick layer at the surface. This metamorphosis into a fibrous texture, the microscopical elements and physical properties of which appear to be of the same nature with those constituting the containing tissue of the blood, or the coats of the blood-vessels, in the living body; allowance being made for the difference and disadvantage of the circumstances under which it is formed.

Lymph, lymph particles, fibrous tissue, and serous fluid, are thus demonstrably phases of blood elements, and the same elements are, more or less, components of vascular tissue. From these and other facts, which it is unnecessary here to recapitulate, we have derived the conclusion that *blood forms its own containing texture*; lymph, vascular lymph structures, and granulations, being the primary or proximate,—and fibrous, tendinous, and osseous textures, the more remote phases of the colourless elements of blood. Degraded lymph, and depraved forms of lymph texture, are termed pus, clots of pus, and tubercle, or tubercular infiltration; persistent granulations are termed fungosities, fungous growth, or, in popular language, “proud flesh:” and it is these depraved and unnaturally persistent forms, together with the adventitious fibrous, tendinous, and osseous formations, arising from the metamorphosis of lymph and new vascular tissue, which constitute the diseased products of inflammation and scrofula. Ossification appears in the coats of the arteries, and *phlebolites* attached to the interior of the veins; inflamed mucous membranes discharge lymph and pus; and inflamed serous membranes assume the aspect of mucous textures, and then their surfaces become united, sometimes by soft lymph-structure, and sometimes by a dense fibrous tissue.* It does not seem neces-

sary, in support of the conclusion we have drawn, to refer more largely to the organization of blood, or to the forms which its elements are capable of assuming, especially as numerous interesting facts may be found brought together in the lectures of Dr G. Burrows, from which we have just quoted. We therefore proceed to the other topic of our inquiry—the limitations of repair; for these appear to indicate the limits of the organization of blood, and explain the common characters of the products of inflammation.

It is well known that the extent and facility with which extreme injuries are repaired is directly as the age of the individual; so that in many of the lower classes of animals a whole limb may be removed at a very early period of life, and be afterwards reproduced,—a phenomenon that does not happen when the full period of growth is more nearly completed. Now, in order to avoid difficult metaphysical questions, we may conveniently express the properties of growth in the embryo, when *all* the organs are evolving and expanding, by the term “*germ power*,” and say that, the younger the individual, the greater the proportion of unexpended or unappropriated germ power:* so that, until the maturity of growth, and in a ratio inversely to the age, there will always be the unexpended portion of the germ power co-operating with the properties of blood and vascular tissue in reparative actions; whereas, when the full maturity of growth has been attained, the reparation of an injury falls wholly within what, by analogy of language, we may call the *blood power*:—that is to say, in a very young animal, specific forms not having been completed, there is a greater capacity of reparation than in an older individual, where these have

agree that at first phlebolites consist of a small coagulum of blood, in the interior of which the *fibrine* becomes pale and concrete; then assumes an *osseous appearance*: and this goes on, little by little, and layer after layer, towards the circumference. Dr. Reid, of Edinburgh, met with five instances of phlebolites within twelve months: they varied in number from two to a dozen; and in size, from a millet seed to that of a large pea. They were loosely attached to the coat of the vein, and nearly all of them were of a *stony hardness*. Two of these bodies were analysed, and found to consist of phosphate of lime, carbonate of lime, and animal matter, in proportions similar to those existing in *bone*. (Pathological Observations on the Blood: MEDICAL GAZETTE, Vol. xviii. 1836.—Edinburgh Medical and Surgical Journal, Vol xliii. 1835).

* Vide Mr. Paget's Lectures on the Process of Repair: MEDICAL GAZETTE, 1849.

* Dr. G. Burrows relates an instance in which *phlebolites*, three in number, were examined by him and Mr. Stanley: two were of the size of filberts, and, upon being divided, exhibited several concentric layers of *fibrine*; in the other there was the same kind of structure, with osseous plates in the investing membrane. One of these bodies was attached to the lining membrane of the vein by *fibrous cords*; and a firm *fibrous band* connected this phlebolite with the others. Tiedemann, Otto, Lobstein, Cloquet, and Carswell, all

been concluded. In the former example, growth is mingled with repair; in the latter, we have repair only.

If the scar or cicatrix of an extensive and deep burn be examined, it will be found that perspiratory pores and hairs are either very deficient or entirely absent in it; from which it would appear that the particular substance of the hair-follicles, and of the glandulæ of the skin, is not reproduced by the process of repair which has healed the wound.* In other cases, too, it appears that muscular fibrillæ, brain substance, liver substance, and the parenchyma of other organs, are not reproducible by the ordinary process of repair—the metamorphosis of lymph. Moreover, inflammation in the brain, in a muscle, in the liver, or in the kidney, does not issue in hypertrophy or increased natural growth of the particular substance of either of these organs, but in forms identical with those which characterise the process of repair—viz., lymph, new vascular tissue, lymph structures, granulations, and pus—and the metamorphosed forms of these—fibrous, tendinous, and osseous forms. What are the inferences to be drawn from these facts? Simply, it appears to us, these: that phenomena of repair by the metamorphosis of lymph, and phenomena of inflammation, are both expressions, as it were, of exaggerated reciprocal action between blood and its containing-texture, and must be investigated apart from the properties of the particular substances prevailing in different organs; that the particular substances of different organs which are beyond the resources of repair, and which do not appear as results of inflammation, are not phases of blood-elements,—they are sustained and nourished by blood, but not derived from it:—whereas those elements and structures which do appear during the process of repair, or in the course of inflammation, are phases of blood-elements. These conclusions appear to derive additional confirmation from further embryological researches: for if the skin or integument of the early human embryo, before it has become vascular, be microscopi-

cally examined, cells of a peculiar character are seen grouped together, and disseminated through it in spots. These, from their symmetrical distribution, and the conformable spaces intervening, appear to be the foundations, or “*the germs,*” of what afterwards become follicles and glandulæ. And as, in the most essential part of the embryo, the governing form (spinal cord and brain) is moulded before the circulation of blood, or the existence of vascular tissue,—so it appears in the skin that the particular substance of its hair-follicles and perspiratory glandulæ is likewise established before the circulation of blood; and it might, *à priori*, have been concluded, that those substances, the germs of which exist prior to, or which are founded independently of blood and vascular tissue, would not be reparable or reproducible by the metamorphosis of the elements of blood, however necessary blood, in its aggregate capacity, may prove to be for their sustenance and growth.

The principal events demanding consideration in repair and inflammation are,—1. The accumulation of lymph or cell-particles, and, 2. The manner in which the coats of the existing blood-vessels are altered, so that blood, flowing in a multitude of new vessels, establishes cell-growth without effusion or loss of its red particles. The latter phenomenon might occur in two supposable ways—either by extension of the coats of the vessels through the newly appearing lymph-bed, or by openings effected in them becoming continuous with the new vessels. What are the facts bearing upon these alternatives?

We have seen school-boys wind a piece of twine tightly around the finger, forcing the blood with great pressure into its extremity,—they have allowed the string to remain on for some time, and, upon its removal, there did not follow any effusion or subcutaneous hæmorrhage. A very vascular nævus may be firmly pressed so as to drive almost all the blood out of its vessels, upon the return of which none of them are found to have been ruptured. The new bloodvessels traversing a lymph or granulation structure, would not for an instant bear the 1000th part of any such treatment without rupture and obliteration. Moreover, we can seldom succeed in injecting the new vessels of very recent lymph, on account of their soft-

* Since this was written, the facts have been substantiated by Mr. Gray, who, in a paper published in the *Lancet*, speaking of the microscopical examination of the cicatrices of burns, states that “no hairs were observed covering the surface of these cicatrices, nor could the existence of sebaceous glands or perspiratory tubes be detected.”

ness or incoherency. These facts seem incompatible with the supposition that the new vessels which appear in repair or inflammation are formed by an extension of the coats of the pre-existing ones, and, in the course of our researches, we have seen nothing to lead to such a conclusion; on the contrary, the coats of newly formed vessels have always appeared altogether different from those of the older ones. The former are pulpy, soft, inelastic, and composed of colourless cells; the latter tough, elastic, and fibrous. And not only is this the case, but it has moreover appeared, so far from the new vessels partaking of the nature of the old, *that the old become assimilated to the conditions of the new*. But let us examine, first, respecting the accumulation of the lymph particles.

The prevailing doctrine with respect to effusion of lymph and accumulation of lymph particles appears to be this:—that effusion of lymph takes place by a species of transudation or exosmosis through the coats of the vessels, and that lymph particles arise from “germs” in the fluid, which grow first as “nuclei,” and then as “cells,” these being developed “as in a blastema.” This account explains nothing as regards the principal and second-mentioned topic of the investigation, inasmuch as nothing is affirmed respecting any change in the coats of the vessels,—a change that must of necessity take place for blood to flow into new channels. There can be no doubt whatever that the fluid element of blood under various circumstances transudes the coats of the vessels,—*simple effusion*,—the coats of the vessels remaining, their elements continuing, their form unchanged. Nor do we assume to deny *the possibility* of cell particles being developed in the effused fluid “as in a blastema.” But we contend that the fact has never been proved, resting only on assumption. On the other hand, the evidence of the senses is not to be repudiated, to the effect that, after irritation, lymph, and lymph particles from the blood, accumulate on the *inside* of the irritated vessels. Having examined the changes produced in the vessels of the *conjunctiva* in purulent ophthalmia, we have found their coats altered, swollen, thickened, and made pulpy,—brought nearly to the condition of embryoniform vessels by the interposition of cell particles

among the natural fibrous elements,—and these have extended from the innermost boundary of the vessels where they touched the stream of blood to their outermost border.* A change of the same kind occurs in the vessels of the gums when they become soft and spongy; and in ulceration where vessels bleed upon the slightest touch, the blood which escapes containing an unusual abundance of colourless cell-particles.

It is not necessary, however, to the prosecution of our present purpose, to determine the question, whether, and to what extent, lymph particles are generated, as in a blastema, in the effused fluid *outside* the vessels; or whether, and to what extent, they accumulate *on their inside* by separation from the blood within. We hold to our conclusions upon this point; and the facts upon which they are based have elsewhere been discussed. It is sufficient that it be granted that cell particles surround and invest the coats of established vessels before new vessels appear.

The inquiry proposed, then, is with respect to the agents which effect the alterations in the older vessels necessary for the establishment of new vascular lymph-growth, and to the opening out of communications between coherent and tough-walled vessels (those of areolar tissue, for example), and the soft, inelastic new ones (those of repair and inflammation, of lymph fabrics and granulations). The evidence required in the investigation has already, to a great extent, been made known.

In the present state of opinion, however, we begin with two preliminary propositions, which may be safely affirmed—1. That new blood-vessels, traversing freshly-accumulated lymph, can make their appearance only after some change (or opening) has been made in the coats of the pre-established vessels; 2. That wherever lymph-particles are accumulated, there some species of vital action, of growth, nutrition, secretion, or absorption, is going on.

In the first period of repair, the action is from blood to the texture: there is effusion, lymph-particles accumulate, new blood-vessels and embryoniform growths appear. There is *deposition* and swelling. In the second stage of

* Healthy and Diseased Structure, plate 3, figs. 6 and 7.

repair, the continued accumulation of lymph-particles ceases, cell-growth is arrested, a great many of the new vessels disappear, fibrous consolidation ensues, and redundant material is removed. There is *absorption*, and swelling subsides. Here are not simply two stages or two periods of one thing, but two distinct things. At first there is clearly an assemblage of matter and forces incompatible with the welfare of established forms, which, considered in themselves, without reference to what may ultimately appear, constitute no reparative process at all, quite the contrary: the action observed during the first four or six days, of a process of repair, *by simple continuation*, becomes morbid. The truly reparative part of the process commences, not whilst lymph-growth is in progress, but when it ceases; when the specific type, the fibrous form, of the containing texture of the blood appears. Such being the case, the first period of repair giving birth to unnatural growth, is morbid; and therefore, whatever may be concluded from our inquiry, applies not only to the first period of repair, but also to inflammation. Forasmuch as there does not appear any necessity for *assuming* a difference in the forces in operation, or in the agents employed in the one and in the other.

Now, *deposition* and *absorption*, growth and destruction, cannot be supposed in progress together, at the same spot, and at the same time, if we speak of the same matter or the same thing; but with respect to two distinct things there are numerous facts in the economy of the living body—physiological and pathological,—proving that these two actions may be and are concurrent. The alimentary mucous membrane is both an absorbing and an excreting surface—so is the skin. There are times when the elements of food are passing into the circulation from the intestine, concurrently with elements of secretion which are passing out from it. The influence of cantharides, from a blister-plaster, is frequently exercised through the medium of absorption, upon the urinary organs, at the time when there is a copious discharge or effusion from the vessels of the absorbing surface. One species of matter deposited or accumulating, another absorbed or taken away. Many other medicinal substances are well known to

be absorbed and carried away in the circulating fluid under similar conditions. The substance of a necrosed bone is in part absorbed and taken away whilst new bone is forming. In the lung, blood absorbs from the air elements which renovate its properties, and at the same time gives off a vaporous exhalation, incompatible with its arterial character and constitution. All these we conceive to be examples of the concurrence of absorption and deposition.

But the phenomena which come nearest to those, the nature and agents of which we would fain discover, are comprehended under the terms abscess and ulceration. In an abscess there is plainly absorption of the surrounding tissues at the time pus is accumulating; and in ulcers the pre-established textures disappear, whilst discharges are flowing away. In an abscess there is tumor or swelling, not because deposition or the generation of cell-forms is the sole phenomenon, but because the new matter being confined, its accumulation forms the most prominent appearance; in ulceration the new matter is not confined, but being too incoherent to retain a form, it falls away and is discharged, whereupon the loss and disintegration of the original texture becomes the most striking effect. The appearances, therefore, are widely different; but in both the same two physiological actions are concurrent, cell-particles accumulating, and pre-established forms disappearing. When a deep abscess makes its way to the surface and bursts, not only the skin, but multitudes of the blood-vessels of the skin, become gradually thinner and thinner, until at length their continuity is broken without hæmorrhage. Such a phenomenon as this cannot be referred to the action of absorbent vessels brought into play by the influence of pressure, for this must be equal on all sides of the abscess, whereas absorption of established textures, and obliteration of blood-vessels, is determined chiefly in one direction, that which is shortest to the nearest surface and safest for the patient. Again, when ulceration is destroying the natural textures, it will often sever blood-vessels of considerable size without any bleeding. Loss of blood from ulceration is the exception, and not the rule. Here, then, we have more than a simple concurrence of deposition

with absorption; for a providently lymph-growth closes and heals the ends of the dissevered vessels in the midst of an otherwise destructive process. These phenomena bear the stamp of cell-agency; and, as each cell, though a microscopic, is nevertheless a whole or individual organism, so mixed changes occur—deposition and absorption—within microscopic areas, which, by the congregation of cells, are effected with greater celerity. The inference here seems borne out by the fact, that in chronic scrofulous abscess, where absorption or thinning away of the superjacent integument comes to a stand, the cell-particles it contains are found broken, collapsed, irregular in figure, and evidently effete “unhealthy pus:” whereas in an acute abscess, where the process of absorption of pre-established structure is almost as active as the deposition of the new material, the cell-particles are round, plump, and unruptured, constituting “laudable or healthy pus”—a matter clearly only a short way removed from lymph, and this more by the greater abundance of cell-particles than by any other feature of difference. Arguing from these facts, the accumulation of cell-forms is no bar to the absorption of pre-established textures. On the contrary, the essential phenomenon of inflammation appears to be the appearance of cell-particles, upon and surrounding the coats of the vessels, which displace the fibrous elements. And, in the absence of any more direct proof upon the subject, we must conclude that, where new blood-vessels are about to appear, the coats of the old ones are previously altered, their fibrous elements absorbed or removed; so that they come to partake, and at length to be constituted of, the elements of the lymph-material in which the new vessels will appear; these replacing elements being the accumulated lymph-particles,—and this whether the accumulation has accrued *outside* the vessels by generation, “as in a blastema,” or *inside* by deposition from the blood, or partly by the one process, and partly by the other. By these operations—accumulation of cell-forms and absorption of fibrous-forms—blood-vessels are prepared for the formation of new vascular tissue.

And it is to this change in blood-vessels, when their fibrous coats are infiltrated, and more or less completely

supplanted by cell-particles, that we have applied the term *retrograde metamorphosis*, from its analogy to certain changes and transformations well known to prevail in vegetable structure. The containing-texture of the blood, prior to the appearance of new vascular growth, truly receding from its specific or concluded form or quality to its primitive or embryoniform condition; whereupon new blood-vessels form, subject to the same laws and provisions as prevail in the embryo-mass originally. And the readiness or facility with which this retrogradation occurs, and the speed with which new vessels appear, would seem to constitute no mean part of the evidence of our conclusion, *that blood forms its own containing-texture, bloodvessels being correlatives of the colourless elements of blood*. In the first period of repair we regard this (the inflammatory process) with reference to the second period, when the containing-texture of the blood reassumes its normal form and characters unaided by medical art; but in morbid inflammation we anxiously desire to stop it, from the uncertainty of the extent to which it may go.

Upon this interpretation we have evidence of *two kinds of deposition*, and *two kinds of absorption*; the one characteristic of the first period of repair, the other of the second period of repair, or of the cure of inflammation. In the first, cells accumulate, and the specific form of the containing-texture of the blood disappears: new blood-vessels and new cell-growths arising. In the second, cell forms, cell-growths, and most of the bloodvessels administering to them, disappear, are absorbed or abolished, the specific form of the containing-texture of the blood at the same time being re-deposited or restored. Thus we have the clearest proof that can be furnished of antagonistic forces. The welfare or permanence of embryoniform cell-growth excludes the normal fibrous structural type of the containing-texture of the blood;—the welfare or establishment of this, on the other hand, excludes the cell-growth: that is to say, the luxuriance of adventitious cell-growth is destructive of natural forms, the reappearance of natural forms destructive of such cell-growth.

The first period of repair (the establishment of cell or embryoniform growth), is necessary to the second,

(the restoration or reappearance of the fibrous type),—in conformity with the laws of original growth; but can be considered as a healing operation only in the same sense that the embryo-structure, which may be obliterated by a touch, is a chicken or a man. Results, in all these cases, are coming forward, which at length establish a concluded type. In the meantime, we cannot define the perfect by the qualities of the incomplete, and say that the first period of repair is a healing operation.

It appears, then, that at all periods of life blood may be determined in unusual quantity to any part of the body upon irritation applied to its containing-texture. This, if the blood-vessels undergo no essential change, is simple congestion, or, to use the technical phrase, *hyperæmia*: it becomes inflammation when cell-forms accumulate, and the coats of the vessels are losing their concluded form. Under various circumstances effusions also take place: these are simple if the blood vessels maintain their normal constitution; but inflammatory, if cell-forms are supplanting fibrous elements.*

Inflammation and organisation are accepted terms, and they comprehend two distinct classes of facts. We refer organisation to an antecedent power or force, and call it "germ-force," "organic life," &c. But, with respect to inflammation, we are not in the same logical position; for we use the word some times in the sense of an agent; at others, as merely expressing the phenomena. Thus, we are apt to say that inflammation does this or that, and also that it consists in this or that. Now it is perfectly allowable, in a philosophical discussion of the subject, if we refer organisation to an antecedent force, to do the same for that class of phenomena comprehended under the term inflammation.†

But we confine ourselves to a simple statement of the phenomena. The elements of blood, under normal circumstances, are subject to the forces which are operative in organisation and natural growth; but in inflammation, or the first period of repair, they emerge from this subserviency, and establish embryonic, and therefore retrograde forms

of growth. These, in a process of repair, are limited in extent and continuance, conforming in due time to the laws of natural growth: but, in inflammatory and serofulous disease, they spread and are persistent, prevailing over the forces which govern and sustain the concluded type, or the fibrous form of the containing-texture of the blood.

In inflammation, abortive repair, and serofulous disease, there is ample room for speculation whether the inherent organising force is too weak or inadequate in some absolute sense, or relatively only to an increased energy on the part of the elements of blood. This is the question substantially at issue when we speak of asthenic inflammation, poverty of blood, and serofulous diathesis. Chemical investigations here come in aid; but we think it must be allowed that variations in the constituents of blood and the secretions, within the limits of health, are too wide for chemical analysis yet to be our guide in practical medicine.

As regards the term retrograde metamorphosis.—In the "scale of organisation," animal bodies which have bones rank higher than those with only fibrous textures, and these higher than the corpuscular or cell-textures, which are esteemed the lowest. But the elements of the lowest forms of organisation—viz., cells—rank higher in *the scale of vitality* than any element of fibrous, tendinous, or osseous tissue. Every cell is a whole organism; whereas bones, tendons, fibrous textures, and blood-vessels, can be parts only of a whole. In the highest, and in all the intermediate forms of living beings between the lowest and the highest, the particular substance of the secreting organs—the liver, kidneys, &c., the most energetic portions of the brain and of the blood—consist of cell-organisms; and it is evident, from all the facts of the case, that a broad distinction must be preserved between elements of *form* and elements of *vital action*. The former have the lowest—the latter the highest vitality. Bones, fibrous-textures, skin, and vascular-tissue, clearly "degenerate" when they become supplanted by particles of lymph or pus, inasmuch as their form and organisation are lost. But, on the other hand, the replacing matter, soft and incoherent though it is, can be said

* Illustrative facts are detailed in our work *On Healthy and Diseased Structure*, p. 284.

† Upon this point see Whewell "On the Inductive Sciences," quoted p. 90, *supra*.

to be "degraded" only in a certain sense; for every corpuscle *which is effective* in the lymph or pus has, far more "vital energy" than any portion of the ministerial textures they supplant. Hence the term retrograde metamorphosis refers, not to vital properties, but to condition or form. And be it remembered, that "life is made manifest to us, not by form, but by acts. It cannot, therefore, be considered as an attribute of uniform character or unchanging intensity." And, judging of the intensity of life by the prominence of the effects, there is far more of life in an acute abscess or ulcer than in the natural structures they supplant, but it is not of the kind or co-ordinated to the species required. The gradual accumulation of pus in spite of many opposing forces of a physical kind—its determination, as it were, to push aside and thin away opposing obstacles—are phenomena of life: and we witness here an exhibition of forces analogous to those which enable the tender plumule of the plant to upturn a giant clod of earth. The organised textures reproducible by the process of repair, and which appear in the products of a cured inflammation or scrofulous disease, hold no very high place in the acts of life. Bones are merely crutches for support, and are notoriously modelled and channelled by the softer tissues; tendons are simply cords attaching the motor-tissue to the bones; and vascular-tissue is subordinate in natural, and even in unnatural growth, to the particular substance—the parenchyma of the organ. For if the brain-substance be malformed or deficient, its vascular-tissue and its bones are generally malformed and deficient likewise; and, in monstrous growth, if brain-substance be unnaturally evolved, exceeding the specific bulk, its vascular-tissue is unnaturally expanded also; and, moreover, the bones of the skull are abnormally expanded, and their number, too, is much increased.

Thus we return to the high significance of embryological researches, where

sentient and motor forms are the first moulded; and being so, blood appears. After these follow the containing-texture of the blood; and, lastly, tendinous and osseous structures;—all in subservience to the leading forms, and these last again subservient to the "power" inherent in the "germ." If this be crippled in the evolution of sentient-matter, vascular-tissue, tendons, and bones, conform to the deficiency. On the other hand, if the nervous centre luxuriate in growth, vascular-tissue and bone luxuriate with it. If the "germ-power" be so much blighted that the leading forms (spinal cord and cerebral ganglia) be not moulded, blood does not appear. Blood not appearing, there can be no vascular tissue; and without this there can be neither tendons nor bone.

It may be objected to the conclusion that bone is a metamorphosed form of vascular-tissue, that if either a wing or a leg of the embryo-chick, when first budding forth on the fifth day, or either of the extremities of the human embryo, when these are not much larger than a mustard-seed, be gently compressed between two slips of glass, and examined with a microscope, all the bones will be seen symmetrically arranged and moulded to their proper shape before any blood or blood-vessels can be seen near them: and, in our figs. i. and ii., p. 194, the dorsal plates are shown as existing at the fortieth and fiftieth hour of incubation. These facts, which might be supposed to militate against, do in truth serve to establish our conclusions. For the substance thus shaped and moulded is a *germ-mass*, entirely composed of soft corpuscles or cells. It is not bone: there is nothing hard—nothing resembling bone. Bone-substance does not appear until some time after this primary form has been permeated in all directions by blood and vascular tissue. So that here, though the form and outline of the future member is cast before blood circulates through it, still *ossification* does not commence except through the agency of the containing-texture of the blood.

PART II.

IN what texture is inflammation seated? If we examine any soft part of the body, we find it composed of parenchymatous substances (nerves, muscles, and secreting substances), intermixed with blood-vessels and sundry forms of fibrous texture.

§ 1. *Of the parenchyma of different organs.*—The particular substances of different organs, as a consequence of the order of development in the embryo (p. 193), become placed outside the blood-vessels, disposed in groups or masses in the interstices between them. These divide themselves, by their physiological offices or functions, into three well-marked classes—*sentient*, *motor*, and *secreting*; which again, upon physiological grounds, are variously characterised and subdivided. Thus, of the *secreting organs*, the parenchymata and secretions are extremely different; of the *muscles*, some are voluntary, others involuntary; and, in the *nervous system*, the physiology of sentient elements differs in each of the organs of the senses. Those of the ear have a very different function from those of the eye, and so on. But let us review generally the plan of the conformation of the body, with reference to the parenchymata of different organs, in as far as they have relation to inflammation. That which appears simple to the unaided vision becomes exceedingly complex examined microscopically.

The skin and mucous membranes are *secreting organs* so much unfolded and spread out, that the parenchymatous substances upon which the secreting actions depend become disposed in distinct spots or groups, each with its separate outlet or duct, the intervals between being filled in with a corresponding development of fibrous tissue. On the contrary, in the internal secreting organs, the groups or lobules of the parenchyma are so closely folded together, that not only is the bulk of the organ very greatly increased, but the ducts unite many times; forming a series of coalescing larger and larger tubes, which demand for their conformation and support a constantly-increasing

thickness of dense fibrous texture, the submucous fibrous basis. But then, that no space may be sacrificed, all the lax areolar forms of fibrous tissue are reduced to the smallest possible compass that is consistent with the magnitude and requirements of the secreting mass.

Passing from the secreting parenchymata to the organs of purely animal life, we observe correspondent groupings and relations. *Muscular fibrillæ* (sarcous elements) are associated in great masses in the voluntary muscles, having between them the smallest possible amount of fibrous inter-divisions. Elsewhere the fibrillæ are spread out in thinner sheets, with a larger proportion of fibrous areolar tissue intervening; and in other places unstriped fibrillæ are distributed in almost single threads.

Sentient elements are congregated in prominent and distinct spots, termed *papillæ*, in the skin. They are exposed in thin and delicate sheets upon the organs of hearing, sight, and smell; but in nerves, spinal cord, and brain, they are folded and disposed within the smallest space. It is to be observed that, for the most part, the elements of the special parenchymata retain through life the cell-form. The prominent exceptions are *medullary tubules* belonging to the nervous, and *sarcous elements* belonging to the muscular system. These in the embryo, and for some period of foetal life, are represented by cell or germ-forms; but during growth there is a metamorphosis to the forms by which they are afterwards recognised. Nerves and muscles, therefore, are not primary but secondary forms; and these appear to re-unite after division, provided their dissevered ends be brought sufficiently near together. But this reunion, or rather incorporation, of medullary tubules and muscular fibrillæ, after division by cutting, does not appear to be a phenomenon of repair by the metamorphosis of lymph, but to arise from inherent properties in the substances themselves—a sort of out-growth of nerve and muscle substance: for, first, it does not seem to take place, except during youth, when, as we have remarked, growth is mingled with repair;

and secondly, when it does occur it is only some time after the process of repair as it relates to fibrous texture, or the formation of the cicatrix, has been concluded.

Now the elements of the particular substances of different organs cannot inflame, except in the meaning of secession, absorption, or disappearance, before new and interpolated forms, or of being intruded upon and deranged by the effects of inflammation. Correctly speaking, upon the testimony of microscopical analysis, inflammation is not seated in brain-substance, liver-substance, or muscle-substance; though we speak of such in consequence of the microscopic character of their relations to blood-vessels. No lengthened argument is needed by those accustomed to microscopical observation, to prove this with respect to the cell-particles and medullary tubules peculiar to the nervous system—the fibrillæ, or sarcous elements of muscles, or the secreting cell-particles of the liver, kidney, and other secreting organs. But if the elements of the parenchymatous substances of different organs do not inflame, inflammation must necessarily be seated in the fibrous textures.

§ 2. *Of the fibrous membranes, fibrous textures, and areolar tissue, skin, and mucous membranes.*—What are the relations of the fibrous membranes?—are they correlatives of blood? Large venous sinuses from the brain traverse the *dura mater*, which are described by anatomists as situated between its laminae, because of the perfect homogeneity of the elements of the coats of the sinuses and the rest of the membrane. The strength and thickness of the *dura mater* have an evident relation to the magnitude of the blood-streams it conveys. The blood-vessels of the *pia mater* are much more numerous and much smaller, and the membrane is in a corresponding degree thinner and more delicate. There is here the same species of fibrous elements in the coats of the vessels, and in the non-vascular parts stretching in the intervals between them. The *pericardium* is a thick fibrous membrane resembling the *dura mater*, and, like it, coincides in strength and thickness with the magnitude of the great vessels from which it is, as it were, reflected to cover and protect the central moving point of the circulation. The *areolar tissue* is one of the most ex-

tensively diffused of all the elements of organisation. So comprehensive is the association of this tissue with the blood vessels, that it would be difficult to point out a single instance in which they are not enveloped by it. Even the capillaries of the coats of the larger vessels are invested by a sheathing of this tissue. The *cutis*, or fibrous basis of the skin, cannot be distinguished from areolar tissue except by the greater condensation and more intricate interweaving of the fibrous elements. “However great the difference may seem to be between the dense and closely-woven texture of the *cutis* and the lax areolar tissue, to which it owes its mobility on subjacent organs, they blend insensibly together. Their ultimate texture is essentially the same.”* The same may be said of the fibrous basis, or the submucous fibrous tissue of the mucous membranes, excreting ducts, and tubes. This blending insensibly together of the different modifications of fibrous tissue furnishes the grounds of an affirmative answer to the question proposed. And such an answer harmonizes with the pathological facts—viz., the completeness with which all the phases of inflammation are exhibited in fibrous membranes: increased vascularity, lymph-growth, granulation, and pus, as belonging to the primary stage or proximate form; and adventitious fibrous texture of every degree of laxity and condensation, and ossification, as the secondary or more remote. But an affirmative answer embraces a very extensive class of textures. What, therefore, is the history of the growth of fibrous membranes? During growth in the embryo, all the fibrous textures appear from our researches to follow, *pari passu*, the phases of the coats of the blood-vessels. When the latter are corpuscular, the former are corpuscular also; the fibrous type is coetaneous in each. In their growing state these textures are not only greatly more cellular, but also greatly more vascular than when their fibrous type is concluded,—a fact which corresponds in a very striking manner with the cell-structure and high vascularity of “granulations,” as compared with the low vascularity and fibrous structure of the “cicatrix.” By these facts we trace relations not only between the cell and

* Pathological Anatomy, by Dr. Todd, F.R.S., and Mr. Bowman, F.R.S.

fibrous types of the blood-vessels and the growth of fibrous membranes, but also between these and the granulations and cicatrix of a burn—*i. e.*, between growth and the first and second periods of repair—the rise and cure of inflammation; so that, whether it be that condensed form of fibrous tissue which, limiting and transmitting the streams of blood, we call blood-vessels,—or that closely woven form which backs and supports the glandulæ and papillæ of the skin and mucous membranes,—or that expanded membranous form which incloses the various parenchymata,—or, lastly, the lax and areolar form which admits of motion between contiguous parts, all are subject to the same pathological law: that is to say, the fibrous textures are the theatre of the morphological properties of blood (of repair, inflammation, and scrofulous disease), because they are correlatives of blood.

Thus we arrive at the full meaning of the terms we have employed to head the present inquiry,—*the containing-texture of the blood*,—a meaning not limited to blood-vessels, but comprehending with them all the variously modified forms of simple fibrous tissue. And we have been encouraged and led on to this comprehensive meaning step by step in our researches, considering that inasmuch as the very small vascularity of a tough fibrous cicatrix does not affect its relations to the previous highly vascular cell-granulations, and through these to the elements of blood, so it appears the small vascularity of a tough and condensed, or lax and areolar form of any original fibrous membrane does not deprive it of its physiological correlation and *consanguinity*.

§ 3. *Of inflammation, the first period of repair, abscess, ulceration, and organic disease.*—Inflammation to the ordinary observer appears as a phenomenon of redness, heat, swelling, and pain. To us it appears as a phenomenon of change or *morphology*, affecting, and limited in its definitive character to textures, correlatives of blood in which *cells and cell-growth supplant fibrous forms*. This definition of inflammation is founded upon the facts which have been discussed, and is corroborated by the distinctions recognised by all of us between congestion, hyperæmia, blushing, and inflammation. In the former the coats of the blood-vessels do not experience any morpho-

logical change or essential alteration of type. In the latter they do; the change from fibres to cells adapting them to the supply of new vessels, and to the support of new growths (p. 318).

Whatever be the view entertained by different pathologists respecting the nature of inflammation, whatever the definition they may deem most appropriate, and whether they regard it in its benign and physiological aspect as the first period *of a process of repair which is to follow* (p. 317), or in its morbid aspect as a destructive process, there can be no possible doubt about the appearance or accumulation of cell-forms—termed *lymph-particles*—upon and around the blood-vessels; nor, looking to the general history and physiology of cells in every department of the animal and vegetable kingdoms, do we think there can be any reasonable question raised as to the lymph-particles being, in the examples we are reviewing, the agents which determine the observed changes, which disintegrate and supplant, or *absorb* the fibrous texture in abscess and ulceration. Lymph-particles cannot inflame. These, as we have before said, are microscopical whole organisms, and as such liable themselves to *inherent deteriorating changes*, which modify their character as physiological and pathological agents, diminish their co-ordinated vital properties, and cause them to appear under sundry microscopic aspects, as exudation-cells, pus-particles, &c.

Thus it seems to be the deteriorating changes in the constitution of the cell-particles, in the example of chronic scrofulous abscess already referred to (p. 318), that retard and render chronic, scrofulous, and incomplete, an action which, had the cell-particles been plump, vigorous, and healthy, might have proved simple inflammation followed by the cure. Weakness, incapacity, and death, in the agents of an operation, stop the work, and lymph-particles, which are irregular and effete, render inflammation chronic, and cure tardy. If the microscope brings us physiologically to a point where the vital energies of cell-particles are the necessary antecedents of fibrous structures, so it brings us pathologically to the same point in interpreting the phases of repair and inflammation. *And, as in growth in the embryo, every fibre taking the place of a cell-particle is an element in natural development contributing to the concluded or adult form of fibrous tissue;*

so conversely, when fibrous textures have been established, every cell supplanting a fibre is an element of retrograde metamorphosis; and according to the conditions of the supplanting cells does this assume the physiological, or degenerate to some pathological aspect.

It is the pre-established, the seceding fibrous coats of the blood-vessels, to which we refer as the seat or subject of inflammation: and as regards them in the first instance, the action is the same whether it leads to repair or ulceration, the difference arising in the one case by normal fibrous forms asserting their supremacy; in the other, by the primary cell-action pursuing an unchecked course. The *reasons* of the difference is the field of speculation (p. 319). Our conclusions are, that textures correlative of blood are the seat, and lymph-particles the material agents; repair, inflammation, and scrofulous disease, the phenomena.

But though the elements of the parenchymatous substances peculiar to different organs do not inflame, they are subject to inherent deteriorating changes. This has been demonstrated with respect to the secreting cell-particles of the liver, and the elements of the vitreous body of the eye, by the observations of Mr. Bowman; and by the researches of others who have employed the microscope with respect to the elements of brain-substance, muscular fibrillæ, and the secreting cell-particles of the kidneys, &c. &c.

And thus we arrive at the anatomical basis of the distinctions recognised in practical medicine and pathology between *organic* or *specific* and *inflammatory* diseases: that is to say, between degeneration or disease of the special elements of an organ, and the changes, interpolations, and intrusions, incidental to the properties of blood and fibrous tissue—phenomena of inflammation.

It is no part of our present purpose to touch upon the subject of organic or specific diseases further than may be necessary to render intelligible the facts connected with inflammation.

In every organ within microscopic areas, there are elements of the common and of the specific.—The elements of the common are blood, blood-vessels, and fibrous tissue; the elements of the specific is the matter of the specific function: therefore there are in every organ of the body, and within

microscopic areas, elements of two kinds of hypertrophy, atrophy, degeneration, and disease—inflammatory and specific. But such is the minute or microscopic scale upon which the different elements of the living structure commingle and incorporate, that before disease can become an object of practical interest disturbed expressions from the *super-added* become mingled with and complicate the *fundamental*: and thus the function of the parenchyma gives complexion to the symptoms of inflammation. For the illustration of these doctrines we go not to the transcendental, but to the practical.

There are assemblages of symptoms in the living, and results to be seen without microscopic aid, in the dead body, which conclusively establish the fact of their being distinguishable diseases, in which the deviation from the standard of health and healthy structure begins in the elements, and progresses from group to group of the parenchyma, the general fibrous basis and the blood-vessels remaining comparatively but little affected, or clearly suffering in a secondary manner; and conversely, that there are other diseases,—scrofulous diseases, for example, in which the persistence of granulations, ulceration, and pus discharges, proclaim a persistent retrograde condition of blood-vessels; fibrous textures overrun with cell-growth constituting the definitive feature of the disorder. In the liver, kidney, heart, and brain, where specific elements are very densely congregated, and fibrous textures reduced to their minimum amount, specific diseases eliminate themselves in a recognised manner from phenomena of inflammation; and in the skin and mucous membranes, where groups of particular substances are comparatively widely separated, and fibrous texture largely developed, the distinctions we are enforcing are not the less well marked and distinguished.

§ 4. *In the skin.*—Small-pox, herpes, lepra, &c. are diseases quite distinct from erythema and erysipelas. The morbid action in the former is circumscribed, limited within a sphere around the glandulæ and follicles, or groups of them; in the latter it is diffused, spreading widely in the common fibrous basis. Evidence to the same effect—and, moreover, we would impress upon the reader, establishing the specific action of poisonous substances—is furnished upon

the application of irritants to the skin. Blisters excite inflammation in the fibrous basis. Croton oil produces a more pimply redness—an eruption: and antimonial ointment causes pustules to arise resembling those of small-pox. In all these instances there is inflammation, a deteriorating change in the coats of the blood-vessels. But in the one class of diseases this is circumscribed about the groups of the particular substances; in the other it spreads widely in the fibrous basis or areolar tissue, irrespective of glandulæ and follicles. In the former examples inflammation wears the aspect of the *superadded*; in the latter, of the *fundamental*.

§ 5. *In the mucous membranes*.—The mucous membranes, composed of a common fibrous basis, and groups of villi, papillæ, glandulæ, and follicles, are analogous to the skin, and are therefore obnoxious, *in virtue of the common*, (bloodvessels and fibrous textures), to congestion, effusion, hyperæmia, anæmia, and all the phases of inflammatory action; and *in virtue of the special*, to specific hypertrophy, wasting, degeneracy, and disease, to pimply eruptions, acuminated pustules, and specific ulcerations. Amongst the diseases of the mucous membranes, Billard distinguishes in infancy the *follicular* from the *erythematic*: and Rokitansky distinguishes in the adult those of the mucous surface from those of the sub-mucous fibrous basis, gelatinous softening of the stomach, and what he denominates *the typhous process*, from inflammation.

“If we consider,” says the latter distinguished pathologist, “that gelatinous softening in none of its stages presents, either at the point of softening or in its vicinity, either hyperæmia, injection, or reddening, and that we are still less able to demonstrate upon the inner surface of the stomach, or in the tissue of its coats, the products of inflammation, we are constrained to infer the non-inflammatory nature of the affection.” “This conclusion,” he says, “gives a key to the various kinds of softening that occur at advanced periods of life under similar circumstances,—viz. in cerebral affections.”*

To follow out physiologically and pathologically the analysis here indicated with respect to the common and

the special in all the organs of the body, microscopic and large, would be, indeed, to enter upon a wide field of anatomical research: enough has been said to indicate the principle, and to eliminate the fibrous textures as the seat of inflammation, repair, and scrofulous disease.

§ 6. *Of repair, and the imperfections or limitations of cure*.—The characteristic pittings of small-pox, and the analogous marks which may be found remaining after a severe application of antimonial ointment to the skin, not only point out upon what texture the morbid action has been concentrated, but they indicate—as do the scars and seams of a burn—that the parenchyma of the glandulæ is not restored or reconstructed by the process of repair, which fills the void, not by restoring the destroyed or lost form, but with simple fibrous tissue. Pathological anatomy has long demonstrated analogous facts in the mucous membranes: and it appears from our observations in these and other examples of repair or cure, where an original or germ-form has been destroyed, that, with the original form and substance, *the principle* governing the natural distribution of the bloodvessels has also departed; for the arrangement or disposition of these in a scar or a cicatrix, in granulations and lymph, appears to us never to be the same as it was in the unimpaired original growth. Such being the facts, we have, in these instances at least, no evidence of a repetition or revival of the “germ force.” On the contrary, we see only effects arising from those qualities of blood which, wherever blood extends, originate a limiting or bounding texture, a correlative of blood, the first phase of which is *corpuscular*, and the concluded form *fibrous*. These imperfections or limitations of cure in the skin may be of little consequence to the welfare of the person; but in mucous membranes and internal organs they become of much more importance: and allied to these in their consequences upon the general or constitutional health are the unnatural fibrous adhesions which very frequently attend the cure of severe inflammation on the free surfaces of fibrous membranes. But we have elsewhere spoken at length upon this part of our subject,* and are therefore content with the following summary:—

* Pathological Anatomy: Sydenham Society's edition, vol. ii. p. 36.

* Healthy and Diseased structure, part ii. ch. 2.

The first phenomenon of repair is inflammation, cells and cell-growth interpolating fibrous texture. The second phenomenon of repair is the cure of inflammation; natural fibrous forms abolish and exclude the cell-growth period. But there is often a pause between these two periods. Inflammation subsides, but cure does not advance: unnatural cell-growths maintain their footing, but they do not spread. *This is scrofulous disease*,—a persistent form of retrograde metamorphosis.

Finally, the human body, regarded *analytically*, is composed of three great systems of organs—sentient, motor, and secreting—nourished by the circulation of the blood, and sustained by the coherency of textures, correlatives of blood. In this point of view we have sought to determine the seat of inflammation, and to extricate its definitive phenomena from their complications with the elements and physiology of the parenchymatous substances. Desirable as this is on many grounds, particularly as interpreting pathological appearances, we must remember that analytical views are unsatisfactory in the practical treatment of disease; because, in the first place, such is the minuteness of the scale upon which different physiological substances commingle and are co-ordinated, that there are everywhere in the living structure, *and within microscopic areas*, elements of the common and of the specific: so that if disease fundamentally begin in the one, it affects the other before it can become an object of practical interest or regard: and in the second place, *synthetically* viewed, all the various elements of the living body are so mutually incorporated and interdependent, that the whole of them form but one person. Look at the relations between *sentient* and *motor* elements. Muscles act instantaneously upon the dictates of the will; but disturb sentient matter, and muscles are divorced from the dominion of the will: they remain quiescent, and waste away. Are not muscles, then, exquisitely sensitive? *Sentient* and *motor* elements are both incorporated with the simple fibres of

the *fibrous tissues*, and immediately feel the influence of the first inroads of inflammation. In the deep interior of the brain *sentient elements* are brought into such close and mysterious relations with the *elements of blood*, that the ordinary form and character of the limiting tissue of the blood is dispensed with, a kind of embryonic type of circulation here prevailing. Blood and medullary matter seem in this instance to have nothing interposed between them. In the *secreting organs, and within microscopic areas*, multitudes of the *secreting cell-particles* are attached to the *containing texture of the blood*: and in the liver the same continuous relations are thought by the best anatomists to prevail between the *secreting elements* and the *venous blood*, as appear to exist in the brain between *sentient elements* and *arterial blood*. It is these synthetical relations which prove to us how dependent every part of the body is upon the circulation of blood, and deprive analytical investigations of the extensive influence which otherwise they must have had upon the art of therapeutics. In the embryo, *germ-masses* or groups of sentient, motor, and secreting elements are founded prior to the flowing of the blood current, but the growth of blood vessels of fibrous textures and bones, upon which the relations of forms and functions depend, is posterior to the circulation; and the healthy constitution of these textures hinges upon a normal metamorphosis of the elements of blood. Such being the facts, what, then, replenishes and maintains the circulating fluid?

In answering this question, we enter upon another and a widely different sphere.

Food, drink, and air, incorporate with blood. Here we pass from the department of the living body to the world of external Nature; and it is to be observed, that the elements of the one cannot be said to be *more necessary to the phenomena* of life and health than are those of the other; for the body dies as soon deprived of air as it does deprived of blood.

